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The Heron Group Annotated Briefing

GeoNetWeaver™
USAID E&E BUREAU SO 1.6 MODEL: AN APPLICATION IN RESULTS-ORIENTED PLANNING AND MONITORING

by

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Acknowledgements and Observations

The Heron Group, LLC would like to express special appreciation to Dr. Loren Schulze, USAID/E&E, who had the vision for funding a pilot effort to use a decision support tool—such as NetWeaver™ and then GeoNetWeaver™--for the purpose of performance measurement. The Heron Group also would like to offer thanks to Joe Atchue of DevTech Systems who coordinated this activity, and special thanks to Casey Delhotal, working at DevTech at the time. She provided data, time, and enthusiasm to the task of development of the knowledge base for the GeoNetWeaver™ SO 1.6 model.

This pilot effort was initiated to utilize a knowledge based decision support tool, called NetWeaver™. Just as the effort began, GeoNetWeaver™ came on line as a complementary tool for use in displaying spatially referenced data in map format, while using the powerful inference engine that is the basis of NetWeaver™ itself.

The focus of the effort was to use the goal/strategic objective of one USAID office (and its associated intermediate results determined to be among those needed to achieve that strategic objective). Working with as a team, a Heron Group Strategic Planner and Knowledge Engineer constructed the dependency networks (akin to a Results Framework in USAID). The Heron Group then input existing data that had been collected over a two year period at the country level across the Eastern Europe and Eurasia region and used the powerful capabilities of the software, analyzed the data to get a sense of progress toward achievement of results. The first model was submitted to the subject matter (or domain) expert at DevTech who had worked on the selection of the indicators and the collection of the country level data for each indicator. The domain expert provided feedback that helped in the refinement of the model.

This annotated briefing is a “snapshot” of some of the major points raised during presentation of the model to USAID. It provides some of the preliminary results of the pilot effort. And, it demonstrates how country level data can “tell a story” about progress toward achievement of regional results. If regional level data had been available, they too could have told a story, perhaps even a different one.

One of the interesting aspects of this effort was the use of GeoNetWeaver™ as a facilitative decision support tool. Whenever The Heron Group made a presentation, the participants became animated. They viewed the data in map format and began to see patterns that data in spreadsheet (or flat files) format did not convey to them. They saw progress toward achievement (or in some cases, lack thereof) of regional results as represented by country-level data. They thoughtfully questioned the validity of indicators. They identified other potential

sources of data to validate (or not) the data used in the first versions of the model. They focused attention on the interpretation of the data. They began to ask questions about allocation of resources, given their interpretation of the results of the analysis. They began to think about other applications of the decision support tool, such as: tracking environmental "flashpoint" areas in the region, monitoring progress across sub-regions such as the Caspian, thinking about the linkages between the intermediate results and the strategic objective, considering the kinds of indicators that might be most appropriate for measuring the strategic objective more directly, the use of qualitative vs. quantitative indicators, etc. We thank the participants and the funder for providing The Heron Group with the opportunity to participate in the rich interactions that provided an important opportunity for group discussion, insight, and learning.

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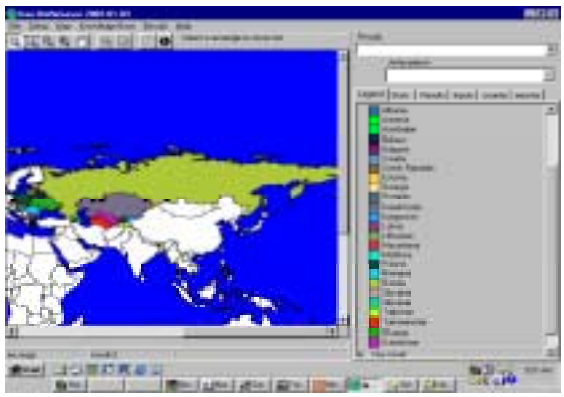
Georgetown, DE
May 15, 2001

GeoNetWeaver™

USAID/E&E Bureau SO 1.6 Model: An Application in Results-Oriented Planning and Monitoring



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Annotated Briefing

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March 6, 2001

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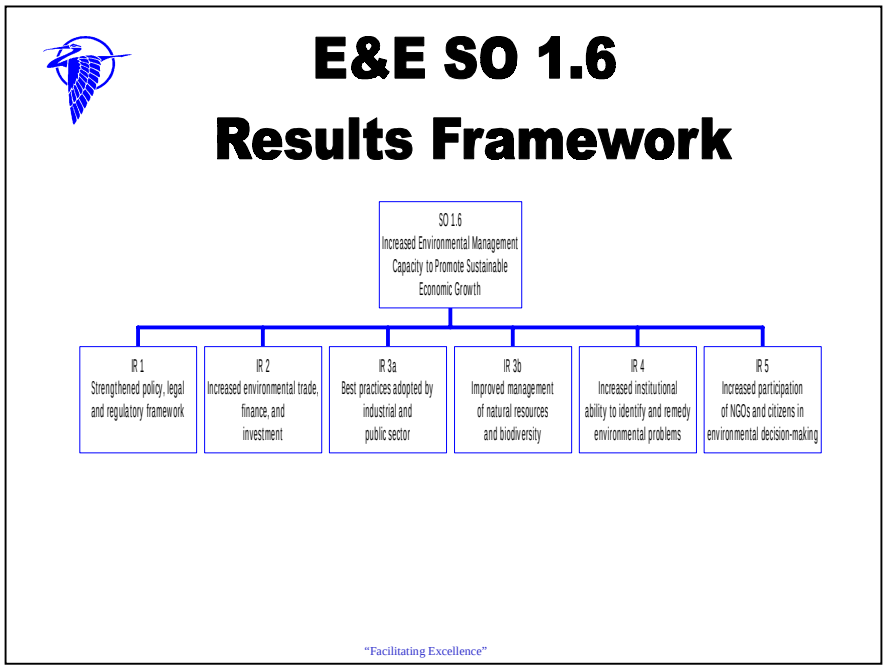

This presentation focuses on a small pilot effort over the past 4 months to look at the application of NetWeaver™ and GeoNetWeaver™. This annotated briefing provides some introductory materials and illustrative details. We began this pilot effort by using the existing Strategic Objective (SO) and Intermediate Results(IRs) for E&E's environmental SO 1.6. These are graphically portrayed above and listed below. Then, we input data we received on the indicators the Bureau uses to monitor progress toward achievement of results. And finally, we used NetWeaver™ and GeoNetWeaver™ to analyze the results.

SO 1.6: Increased Environmental Management Capacity to Promote Sustainable Economic Growth

IR 1: Strengthened policy, legal and regulatory framework

IR 2: Increased environmental trade, finance and investment

IR 3a: Best practices adopted by industrial and public sectors

IR 3b: Improved management of natural resources and biodiversity

IR 4: Increased institutional ability to identify and remedy environmental problems

IR 5: Increased participation of NGOs and citizens in environmental decision-making

Brief Introduction to NetWeaver and GeoNetWeaver

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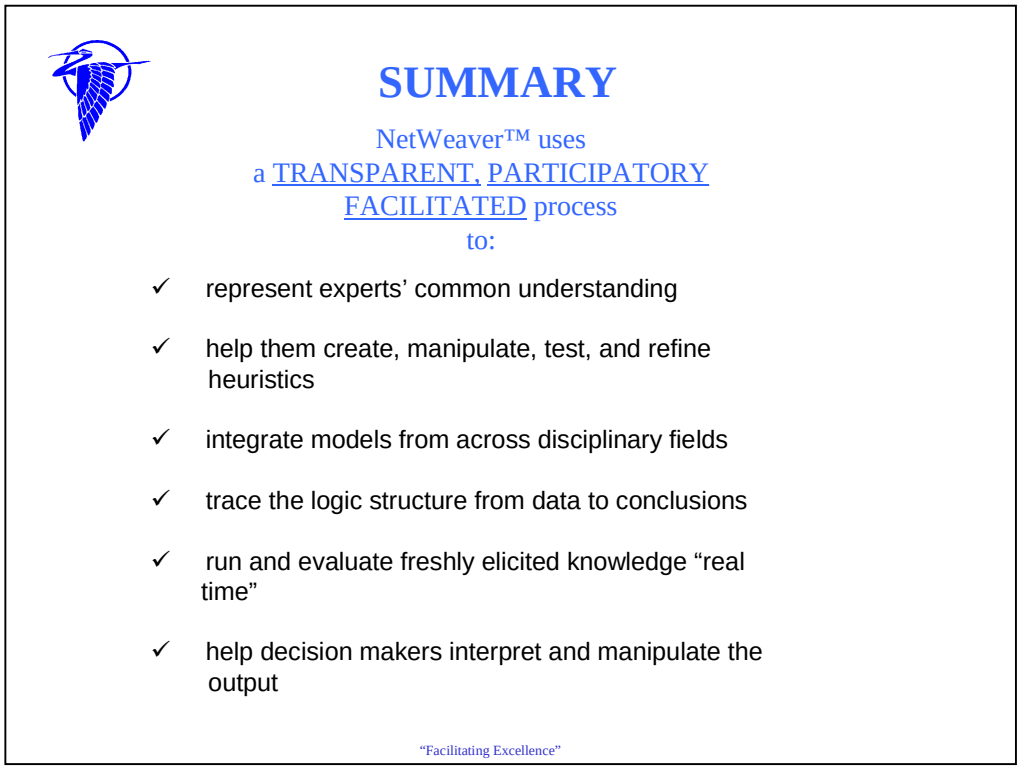
NetWeaver™ is an Artificial Intelligence shell developed by Michael C. Saunders and Bruce J. Miller at The Pennsylvania State University. They originally developed NetWeaver™ for use on complex natural resource issues. NetWeaver™ is now being used by the U.S. Department of the Interior (USDI) Fish and Wildlife Service, the Environmental Protection Agency (EPA),and the U.S. Department of Agriculture (USDA) Forest Service. NetWeaver™ is also being used by USAID's AFR/SD/ANRE to analyze community-based natural resource management (CBNRM). This is the first application in USAID of a new version of NetWeaver™, called GeoNetWeaver™, that represents data in spatially referenced (map) format. The Heron Group, LLC is working with USAID to see how NetWeaver™ and GeoNetWeaver™ can be used to address complex issues in sustainable development.

Part of the challenge of sustainable development is how to handle data, information, and knowledge. All add to an understanding of the nature and magnitude of complexity of systems and the connections and dynamics between components—including biophysical, social, economic, political, and organizational—of those systems.

New tools, like NetWeaver™ and GeoNetWeaver™, can assist organizations like USAID in addressing the complexity of systems in which sustainable development takes place. In this case, we have used GeoNetWeaver™ to analyze E&E Bureau's environmental SO 1.6 to look at how a decision support tool can serve planners, managers, decision makers, etc. in strategic planning and performance monitoring efforts.



NetWeaver™

1. represents the experts' common group understanding of a complex system;

2. helps experts create, manipulate, test, and refine heuristics (i.e., decision models or the rules by which professional and indigenous experts understand and respond to a given situation or problem) that demonstrate the logical relationships between and among variables and linkages between the individual parts and the whole;

3. integrates models from across disciplinary fields to better reflect the complexity of the actual management decision making context;

4. provides the ability to trace the logic structure from data to conclusions as well as from conclusions to data;

5. runs and evaluates freshly elicited knowledge "real time" while the domain expert is present;

6. helps decision makers interpret and manipulate the output of the decision model that provides mathematically robust knowledge about complex problems and that has been used to evaluate less than precise information

GeoNetWeaver™ uses
a TRANSPARENT, PARTICIPATORY,
FACILITATED process
to:

- ✓ do full depth analysis of all decision criteria (using the power of its NetWeaver™ foundation) using data across multiple scales and from multiple sources
- ✓ display spatially referenced data, and not specifically spatially referenced, in map format
- ✓ provide a visual presentation similar to a geographic information system

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GeoNetWeaver™

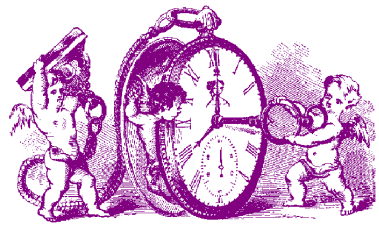
1. analyzes (using the power of its NetWeaver™ foundation), in full depth, all data across multiple scales (e.g.,1:5,00; 1:50,000) and from multiple sources (e.g., district profiles, soil maps, watershed assessments) for criteria being used for decision making at any and all places;

2. displays spatially referenced data or data not specifically spatially referenced (i.e., it may be from a tabular database at a country level but is not specifically spatially referenced to a given site) in map format;

3. provides a visual presentation of a geographic information system but without the overhead of learning and using a full-blown GIS

The NetWeaver/GeoNetWeaver Generic Process

Knowledge Elicitation



Knowledge Representation

Knowledge Verification

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NetWeaver™ is not a traditional expert system, nor is it the 1970s version of Artificial Intelligence software. NetWeaver™ is a tool used by Knowledge Engineers working with Domain (Subject Matter) Experts to build knowledge bases that produce executable models. NetWeaver™ is an interactive, computerized tool that uses the following process:

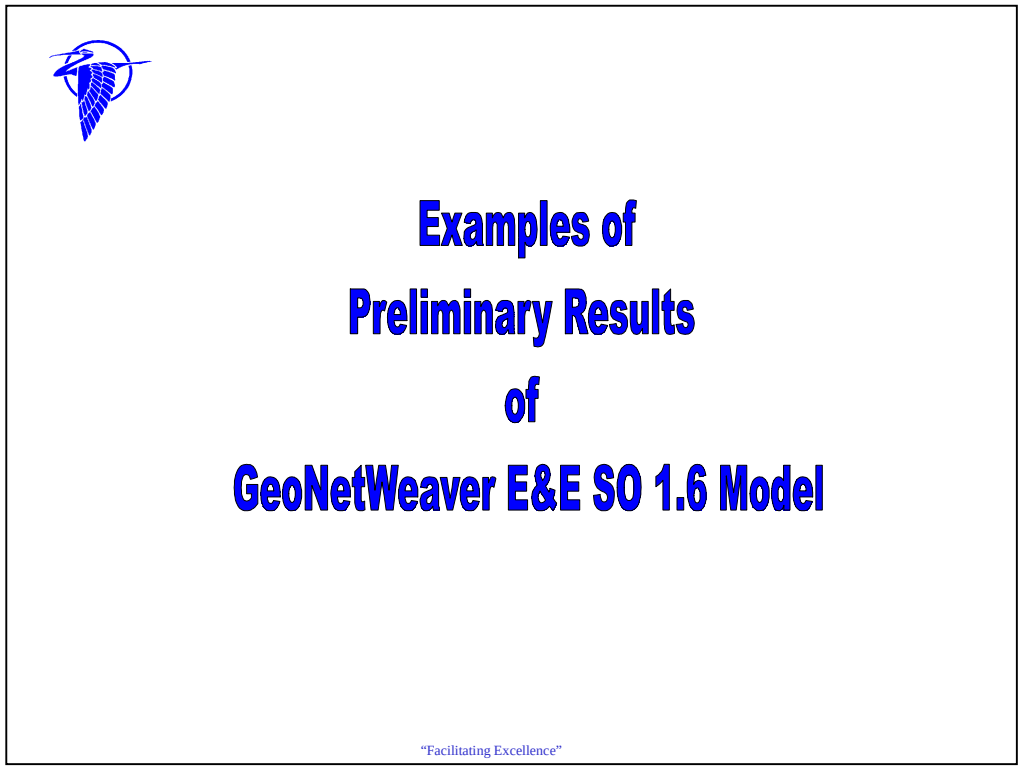
Knowledge Elicitation--This involves the transfer of area specific knowledge from Domain Experts to the Knowledge Engineer.

Knowledge Representation--This involves the incorporation of coding the elicited knowledge by the Knowledge Engineer into NetWeaver™

Knowledge Verification--This involves the testing and verification of how well the incorporated knowledge represents what the Domain Expert knows

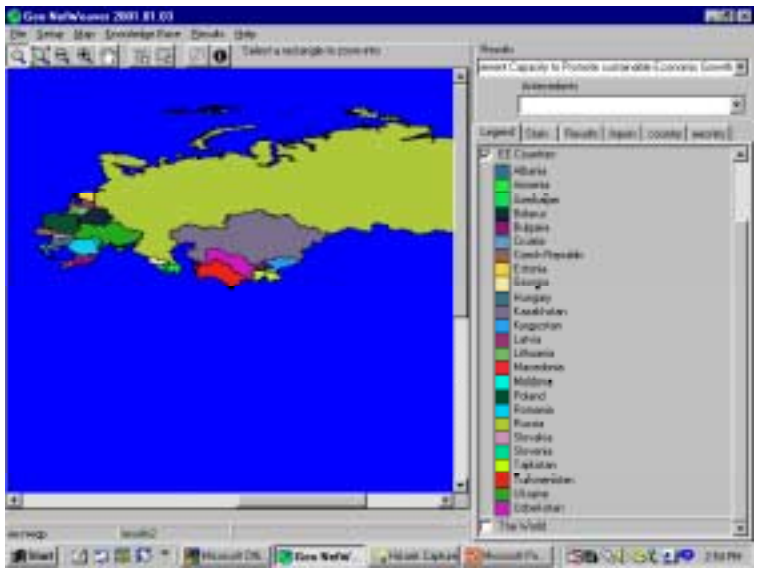
Through this process, it is possible for Domain Experts to articulate the logical relationships and linkages between the individual parts and the whole. However, new tools, like NetWeaver™ and GeoNetWeaver™, increasingly are available to condense, process, filter, organize, categorize, and analyze disparate pieces of information and then present it as a new synthesis, as knowledge.

We've used GeoNetWeaver™ to model the dependency networks but in this case it is both WYSIWYG--What You See Is What You Get—as well as WYDSIWYAG (What You Don't See Is What You Also Get). What we mean by this is that the map you see is like the face of a watch with the hands on the dial. It is straightforward, easily read, and easily understood with the legend. What the map alone doesn't show are the actual dependency networks, the data, the inference engine, and the analytical tools "inside" that are the foundation of the maps. Because like any watch, it isn't necessary for everyone to understand how the watch works in order to tell time. The Knowledge Engineers (the cherubs above) know the inner workings. However, it is possible for others to learn how to access the dependency networks/results framework and data by "drilling down" into the model.



This begins a brief display of screen captures from the GeoNetWeaver™ E&E SO 1.6 model developed over the past few months by members of the Heron team working with Casey Delhotal at DevTech Systems. She provided background material on the Results Framework and two years of data for each of the indicators on Excel spreadsheets. She also worked with the Knowledge Engineers to do a sensitivity analysis after the first version of the model of dependency networks and data were input. The results you will see in the presentation and in this annotated briefing are from version 2 of the model.

E&E Region Portrayed on GeoNetWeaver



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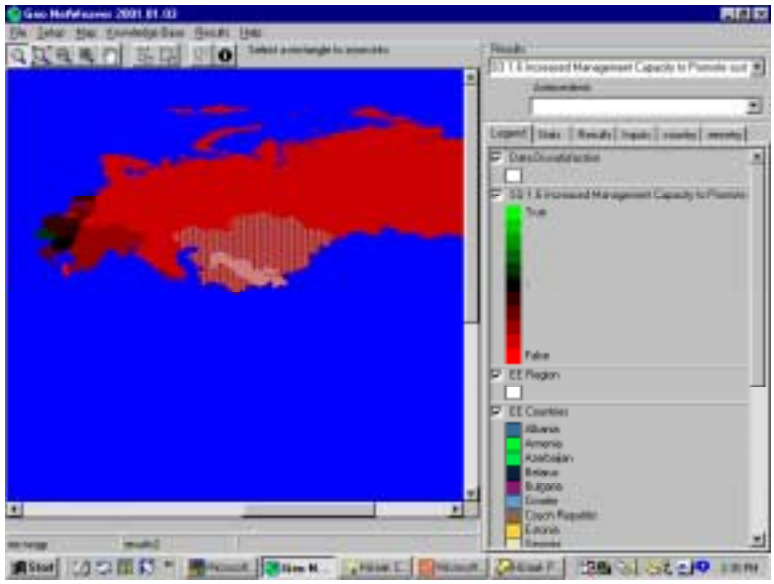
When GeoNetWeaver™ is opened, a map of the world appears. If you want to select a given region, the software can be directed (as above) to show just the countries in that region, with borders between countries, with different colors to differentiate what country is where, and a legend to link the name and country for easy reference as above. It is also possible to include country names on the maps for easier reference to the countries that are being viewed.

Here, we show the Eastern Europe and Eurasia region, as denominated by the U.S. Agency for International Development.

Results of GeoNetWeaver Analysis of Data by Country for SO 1.6



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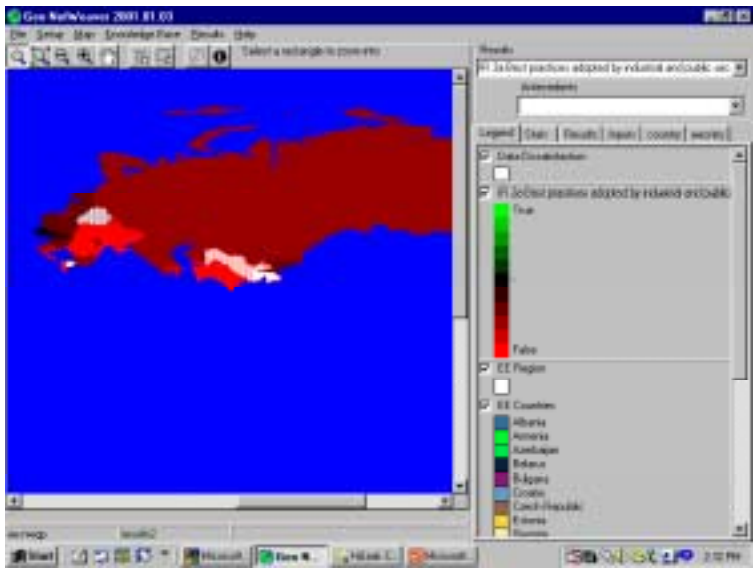
When the data for each country are loaded into the GeoNetWeaver™ model, these are the results. Most of the region appears in various shades of red, indicating that progress toward achievement needs to be improved. Note the area in black. This may reflect that some progress has been made. Also note that some countries have some cross hatchings and appear here with more whitish coloration. If you look at the "Legend" tab that appears on the right hand side of the screen, you will see that a small box, called "Data Dissatisfaction" has been checked. This is a helpful feature of GeoNetWeaver™. It immediately identifies areas where data are perhaps non-existent or where data have been deemed questionable by the Domain Expert.

NOTE: The data used in this model are for a 2 year period. The sources of the data are from non-USAID references, including FAO, EBRD, and WRI. Indicators are as direct as possible, but some are proxies. No regional data per se were available for the indicators. The data were collected at the individual country level, so actual "results for the region" are country results that can only reflect regional progress in an indirect sense.

Results of GeoNetWeaver Analysis of Data by Country for IR 3a (Industry and Public Sector Combined)



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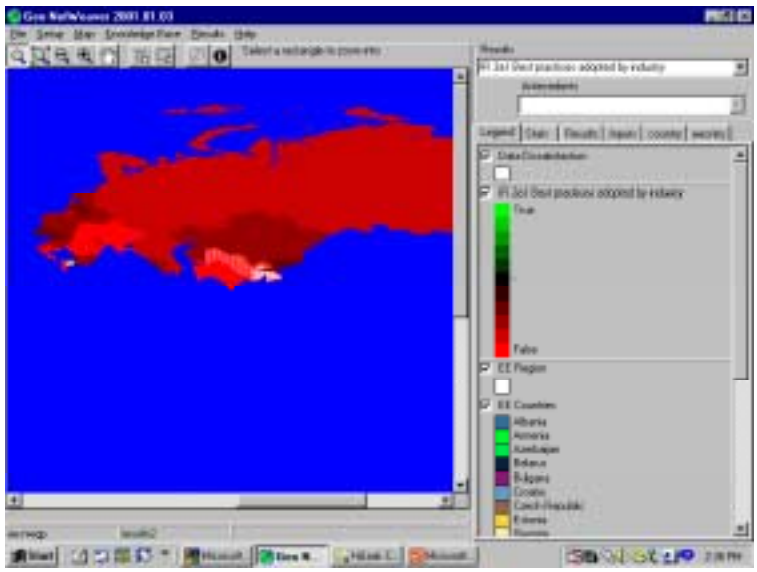
This is just one of many possible examples of the results of this GeoNetWeaver™ analysis, specifically IR 3a—Best Practices Adopted by the Industrial and Public Sector. This shows the GeoNetWeaver™ analysis of data by country on progress toward achievement of results when you combine the data for both industry and public sector efforts to adopt new practices. You can see some changes in color in terms of less overall bright red as compared to the previous slide that shows results at the overall SO level. Here we see a country like Russia seems to be making some progress when we look at the combined data. Poland still remains in the category of almost making positive progress. More countries here, however, show they they fit into the category of "data dissatisfaction".

But, it is important to look at differences when data are disaggregated—i.e., by industrial sector and public sector, as per the next two slides. They tell a different story than this one because of the process of disaggregation.

Results of GeoNetWeaver Analysis of Data by Country for IR 3a (Industrial Sector)



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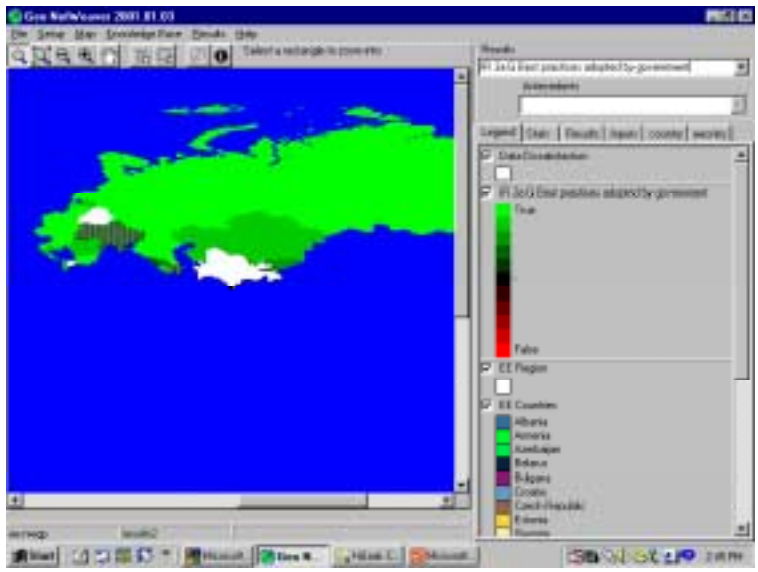
The analysis of data for the industry sector show some significant differences from the previous slide (i.e., the one that shows the results when data for industry and public sector efforts to adopt new practices are combined). As before, even when disaggregated, most of the countries are on the bright red to darker red side. There seems to be less "data dissatisfaction" on the part of Domain Experts relative to the data portrayed here.

In general, this map provides decision makers and managers with an opportunity to discuss issues related to where and how progress might be made on a variety of fronts in the industrial sector. They may also want to discuss issues such as reallocation of resources from other IRs to make progress in this sector overall or perhaps only in given countries. Or they may decide that resources should not be allocated to this sector at all, etc.

Please note, that we will "drill down" into the data during the oral presentation, and more details on data about this specific IR also are highlighted later in this annotated briefing.

Results of GeoNetWeaver Analysis of Data by Country for IR 3a (Public Sector)



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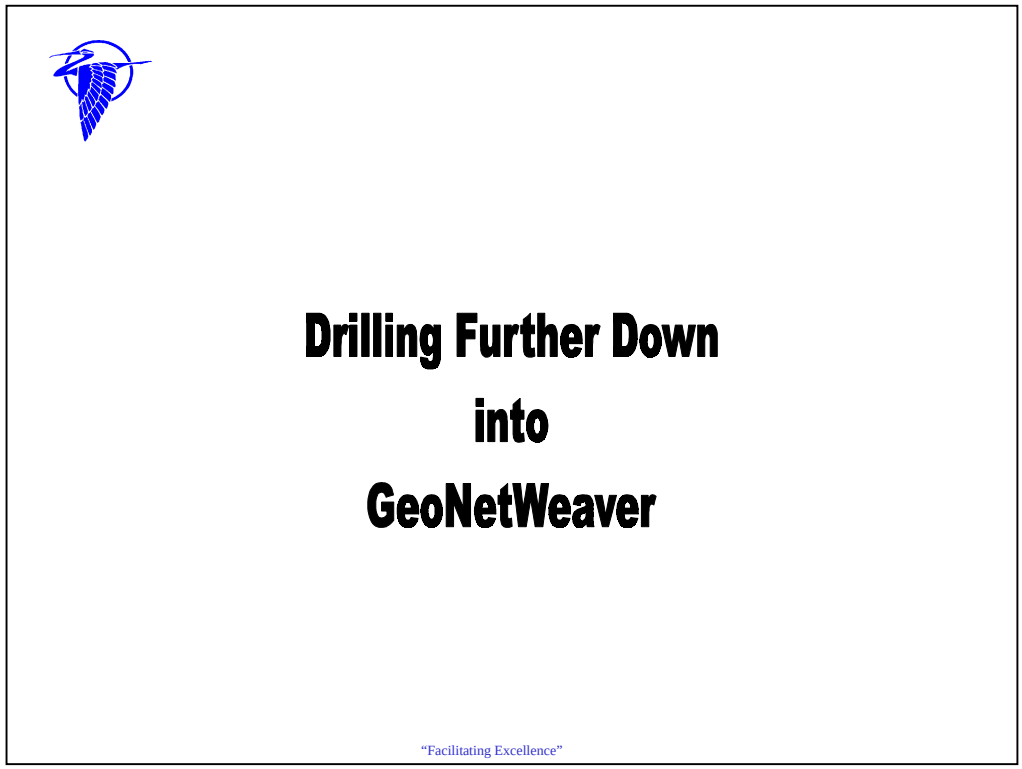
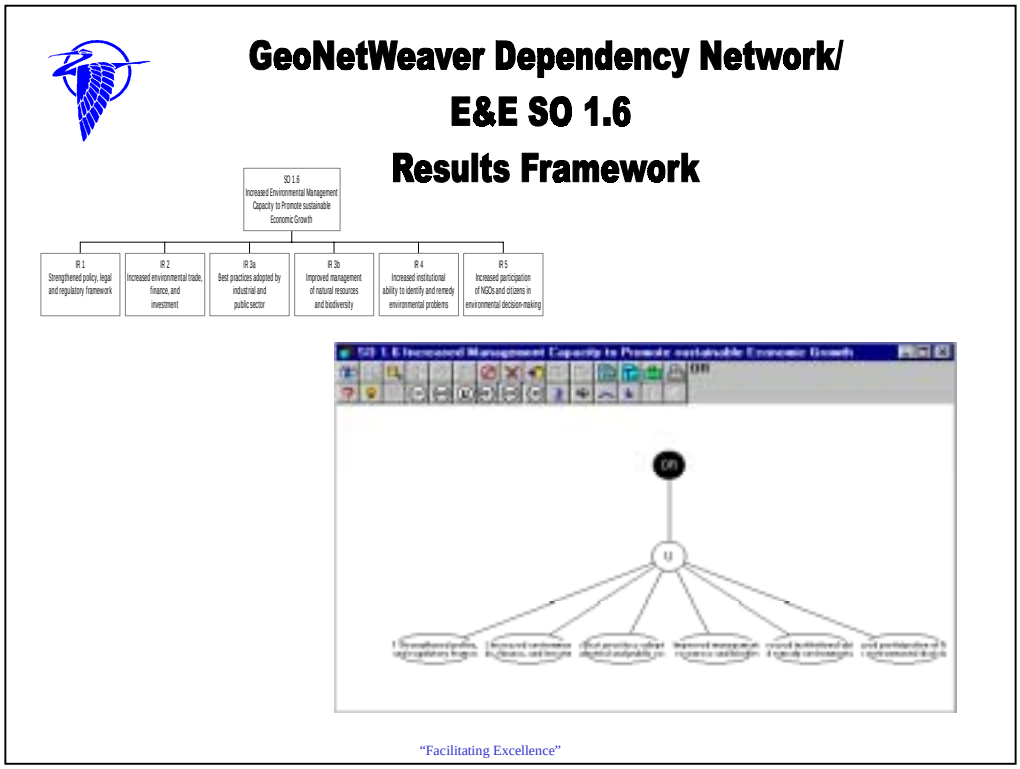
When disaggregated from the industrial sector, the data for the public sector show a considerably different picture. Things look pretty good since so many countries graphically appear to be on the more positive side (as portrayed by different colors of green, with the brightest shade being the most "true" or positive).

Decision makers may decide that no further effort needs to be expended in this sector. However, looking at the indicators that have been used may provide decision makers with an opportunity to reflect on what these results really mean in terms of non-capital city populations which the data for the public sector part of this IR measure.

More details on this can be found in following slides.



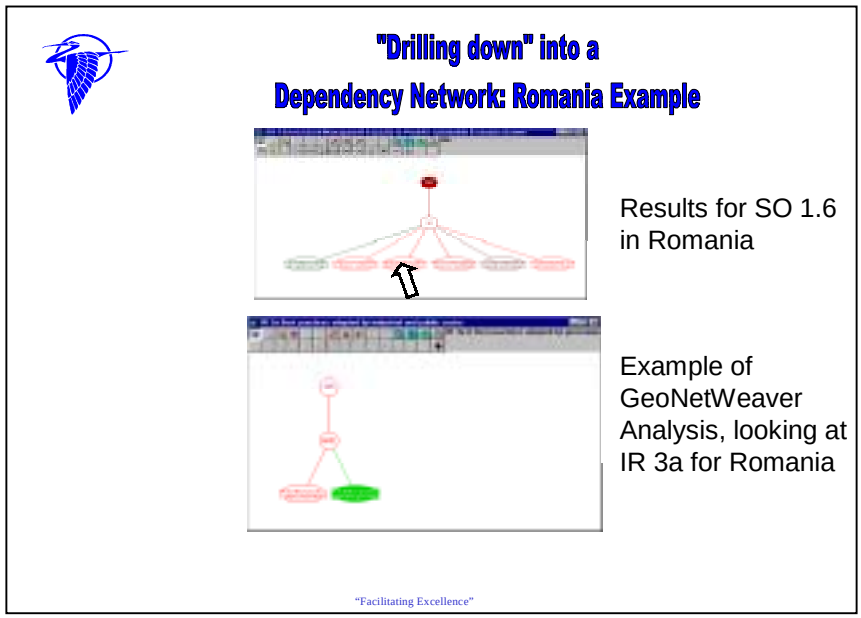
The next slides focus briefly on one country and the results as one "drills" further down into GeoNetWeaver™.



First, let's start by showing a small bit of what you get when you "drill down" into the model. This screen capture illustrates how GeoNetWeaver™ constructs dependency networks that are akin to Results Frameworks in USAID. This is the familiar part of any USAID results-oriented planning effort.

Each of the ovals in the bottom diagram represents one of the IRs you see in the Results Framework. They indicate that another level of dependency or data boxes exist. By clicking on the oval, you can follow a particular dependency link to more details. (See next slide)

NOTE: The following two slides show the results for IR 3a when we look only at the data for the randomly selected country – ROMANIA.



The top box is the dependency network showing the results for Romania have been loaded and processed. Intermediate Results (IR) 1 and IR 4 are close to showing that the country is making limited positive progress. The other IRs are fundamentally not showing progress. Thus, if one follows the logic that **IF** IR 1, AND 2, AND 3a, AND 3b, AND 4, AND 5 all have to be true (green in a NetWeaver™ or GeoNetWeaver™ graphic display), **THEN** the Strategic Objective (SO) itself (for Romania in this case) must be green. However, in this case, **IF** any IR is 100% FALSE, **THEN** the SO is FALSE (or not achieved), hence the red on the top graphic. But, let's drill deeper to see what some of the individual data for a given IR tell us about what progress is being made toward achievement of results in Romania.

If the Knowledge Engineer clicks on the ovals such as those shown here, you can go "deeper" into the model to data boxes that have associated indicators, and when refined the model provides even more detailed information about assumptions, explanations/descriptions, citations, etc.

The "nesting" of networks and the modularity of NetWeaver™ and GeoNetWeaver™ that you will see throughout the presentation are key elements that demonstrate executable models based on expert knowledge. Having a modular knowledge base design means that the complexity of the total system can be broken down into smaller units or modules that are much easier to develop, understand, represent, and verify. Getting consensus for each module means that a large knowledge base can be quickly built by aggregating already verified smaller modules. But, as mentioned above, the verification process is much quicker for smaller modules.

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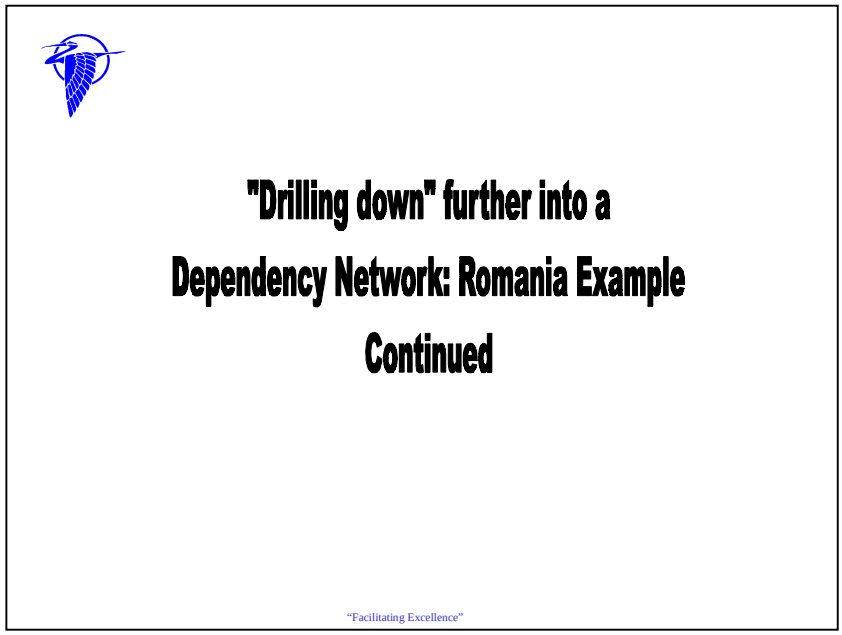


The example on the previous page shows how IR3a has been disaggregated into additional ovals—one for practices adopted for the industrial sector; the second for practices adopted for the public sector. This kind of disaggregation allows for more clarity in analysis of multidimensional results when the data for the public sector are obviously very different from those for the industrial sector. The indicators are very different, and this graphic illustrates an example where measurements of indicators for the industrial sector are definitely not being met (as reflected in the red oval), but measures for the public sector are being met (i.e., green oval) according to the data used.

Indicators for Romania's **industrial sector** are:

-Energy Efficiency (i.e., GDP per unit of energy use (1995 US$ per kg of oil equivalent))

-Emissions from Industrial Processes (i.e., CO emissions from industrial processes in kg per 1995 US$ of GDP)

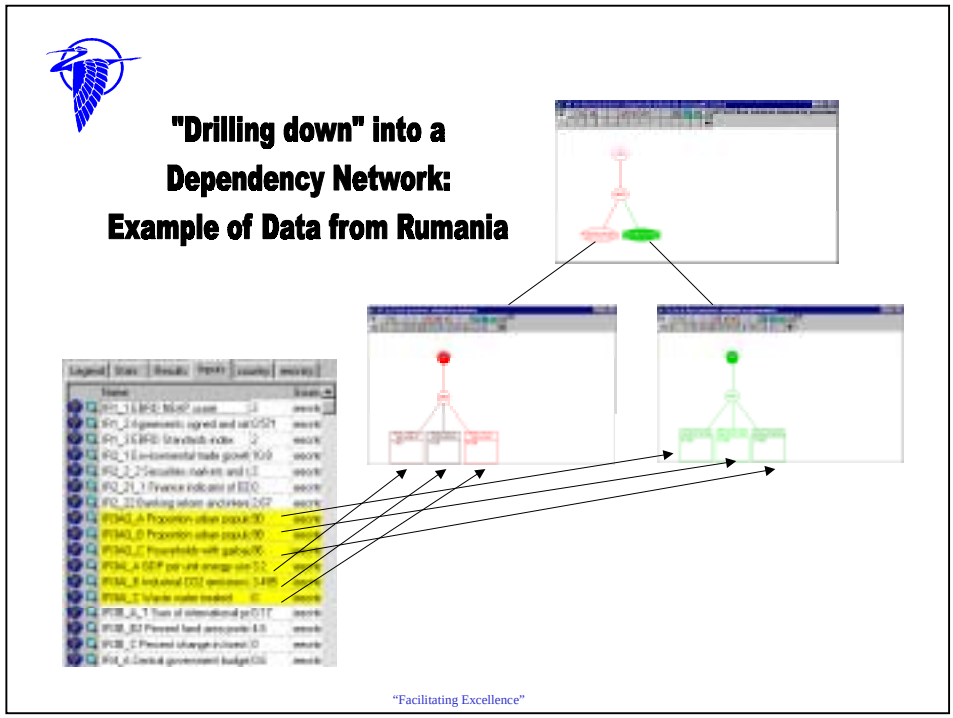
-Waste Water Treated (i.e., percentage of wastewater treated)

Indicators for Romania's **public sector** are:

-Access to Sanitation (i.e., proportion of urban population with access to sanitation in capital city)

-Access to Safe Water (i.e., proportion of urban population with access to safe water in capital city)

-Household with Garbage Collection (i.e., percentage of households with garbage collection in capital city)



"Drilling down" by clicking on the red oval (i.e., the top box), you will see the data boxes with Romania's Industrial Sector's 3 indicators. The colors are slightly different as you can see. There are a couple of easy options to look at the data. For this example, we have clicked on the "Inputs" tab on the GeoNetWeaver™ screen (see box on left of slide).

Indicators for Romania's **industrial sector** are:

-Energy Efficiency--GDP per unit of energy use (1995 US$ per kg of oil equivalent) is 3.2 on a scale of 1-8.5 (thus the box is a dark red)

-Emissions from Industrial Processes CO emissions from industrial processes in kg per 1995 US$ of GDP is 3.495 kg per 1995 US$ of GDP on a scale of 1-8.5

-Waste Water Treated (i.e., percentage of wastewater treated) is 0% treated on a scale of 0-100%, thus is it bright red

Following the Boolean operator "AND", IF any one of them is FALSE, then all of them are False, hence the red oval.

Indicators for Romania's **public sector** are:

-Access to Sanitation--proportion of urban population with access to sanitation in capital city is 90% with access

-Access to Safe Water--proportion of urban population with access to safe water in capital city is 98 % with access

-Household with Garbage Collection--percentage of households with garbage collection in capital city is 86% with collection

Again, looking at the Boolean operator AND, as this has been constructed, this is True only if all paths to it are TRUE, hence the green oval above.

Some Issues for Discussion

1. Process used to date?

2. Next steps for model refinement?

3. End-user(s) of this model and associated training needs?

4. Quantitative and qualitative data and how GeoNetWeaver handles them?

5. What else can NetWeaver and GeoNetWeaver do?

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We understand that the brevity of this presentation will undoubtedly raise some questions. We believe that some of the significant issues that need to be discussed in greater detail and over more time are listed on this slide. We welcome these and any other questions participants may have during the Q&A period or after the presentation today.

While results-oriented planning, performance monitoring, and analysis of progress toward achievement of results are the focus of this particular effort, it is important to note that among the other possible uses for NetWeaver™ and GeoNetWeaver™ include, but are not limited to: famine prediction, reduction of economic and social impact of natural disasters, data needs assessment, trends analysis, risk rating system for various scenarios, and other technical issues. Not discussed here is NetWeaver's and GeoNetWeaver's capability to use FUZZY LOGIC. And, both programs can create new databases or extract data directly from other linked databases (e.g., GIS), and can deal with situations where data or incomplete, non-existent or not easily quantified. These too may be areas of interest that participants may want to explore.

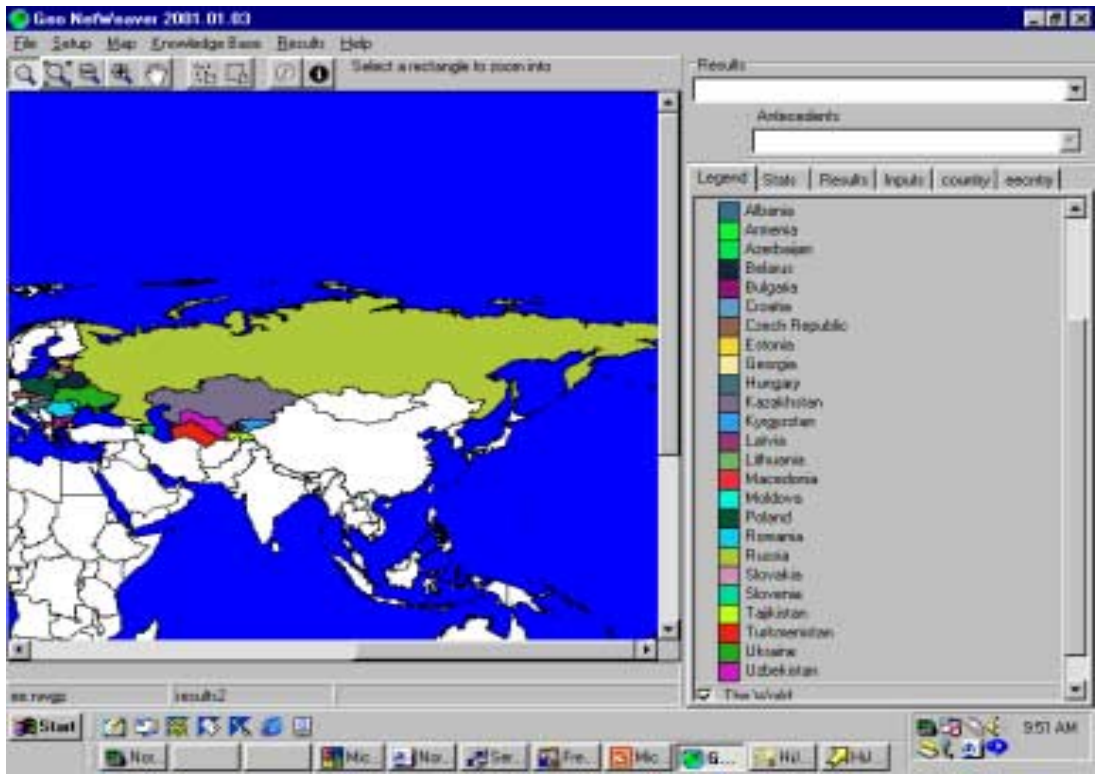
The Heron Group website www.herongroupllc.com has two reports. One deals in a limited way with NetWeaver's fuzzy logic capability. The second deals in detail with the application of NetWeaver™ to CBNRM activities in Africa.

Annex:
Selected full screen slides for easier viewing

GeoNetWeaver™

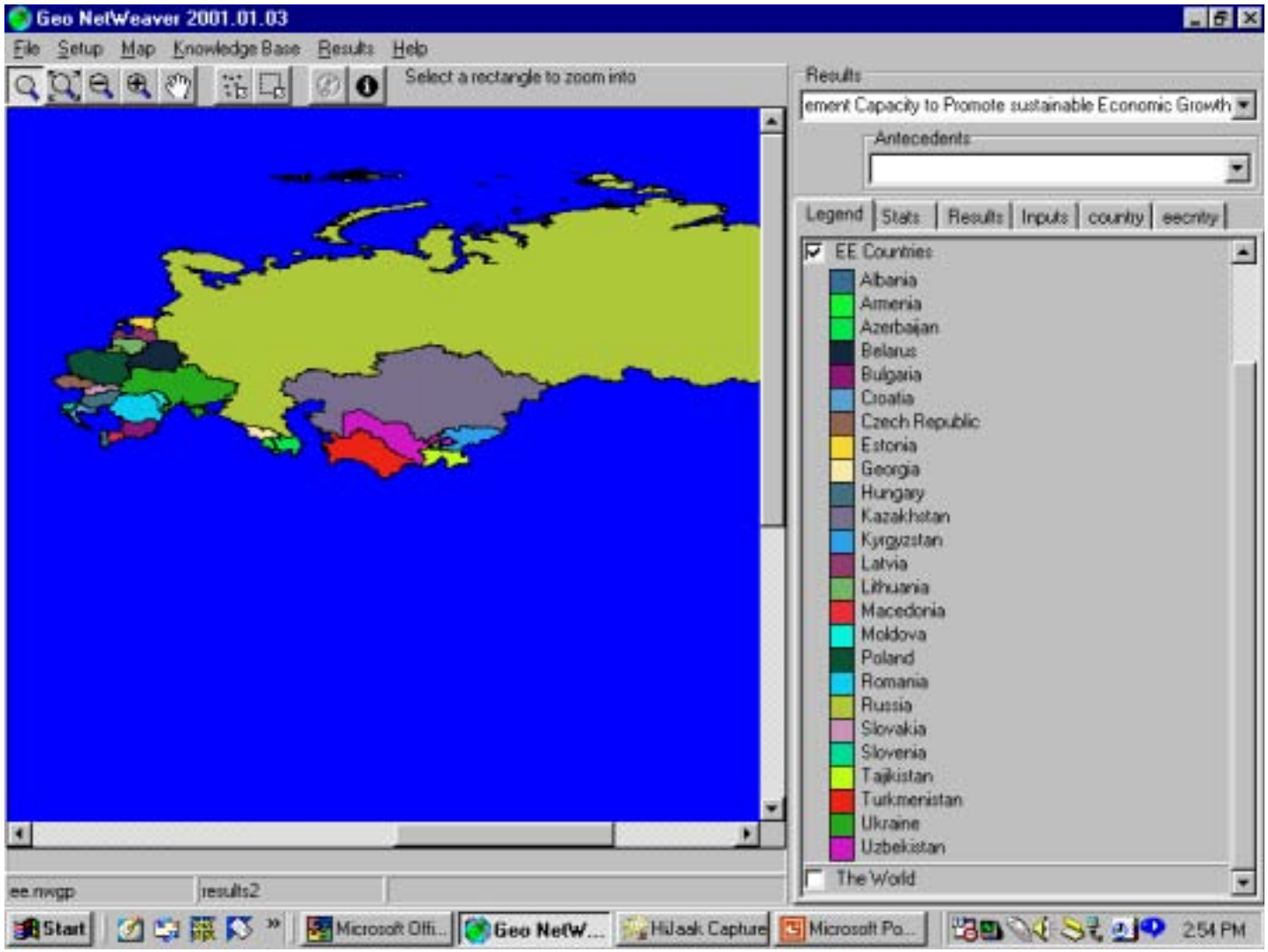
USAID/E&E Bureau SO 1.6 Model:

An Application in Results-Oriented Planning and Monitoring

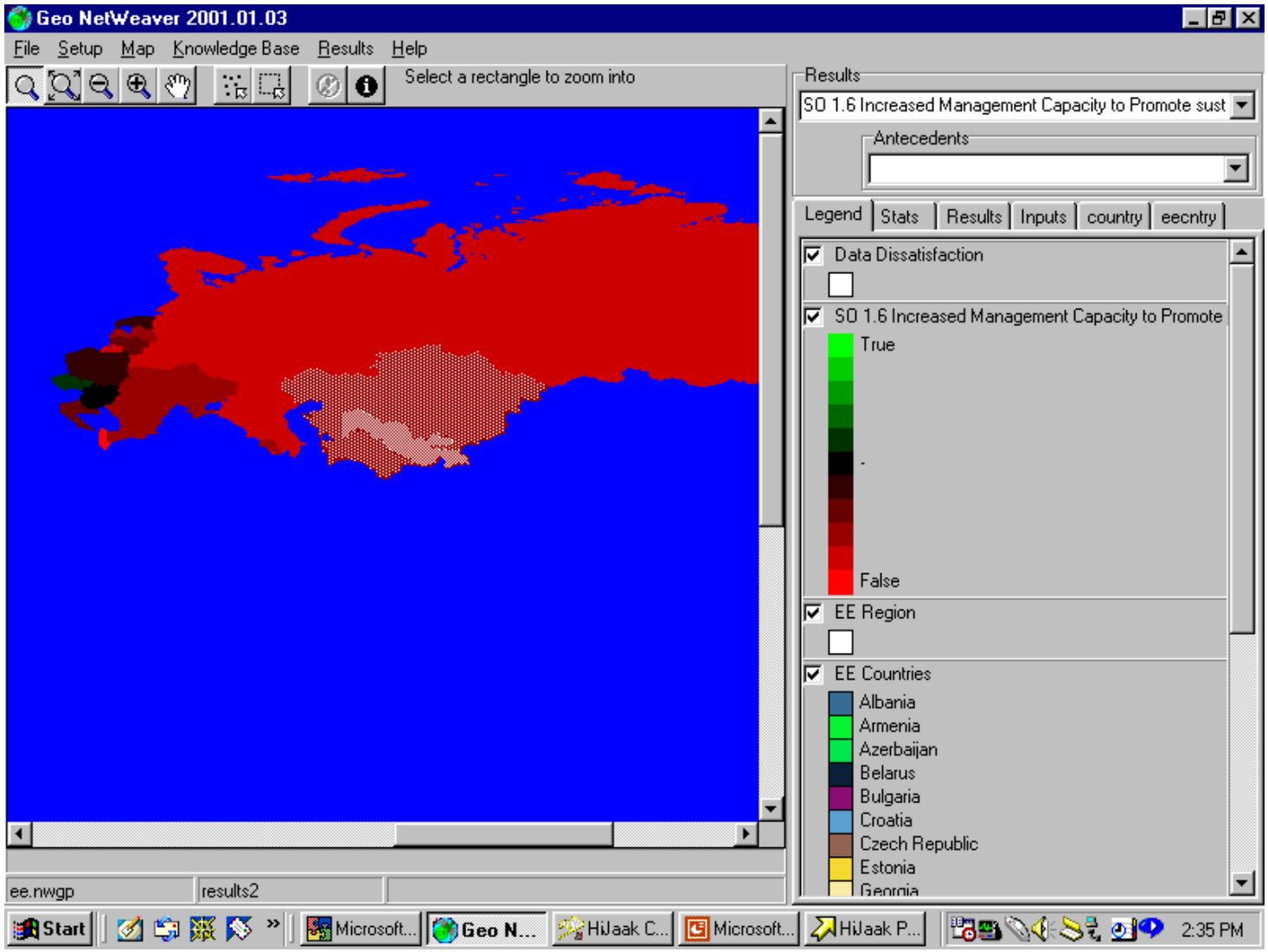


E&E SO 1.6
Results Framework

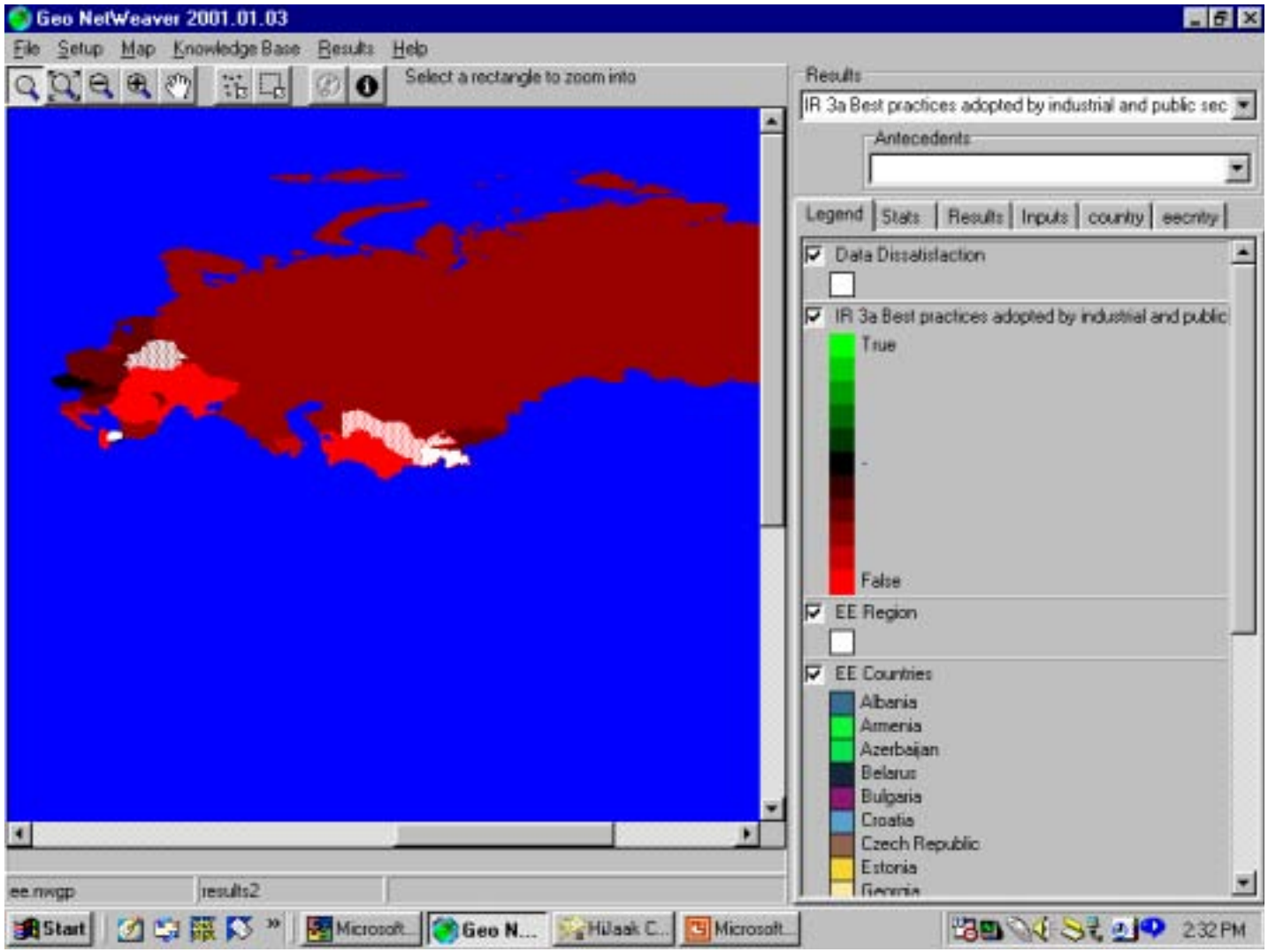
E&E Region Portrayed on GeoNetWeaver



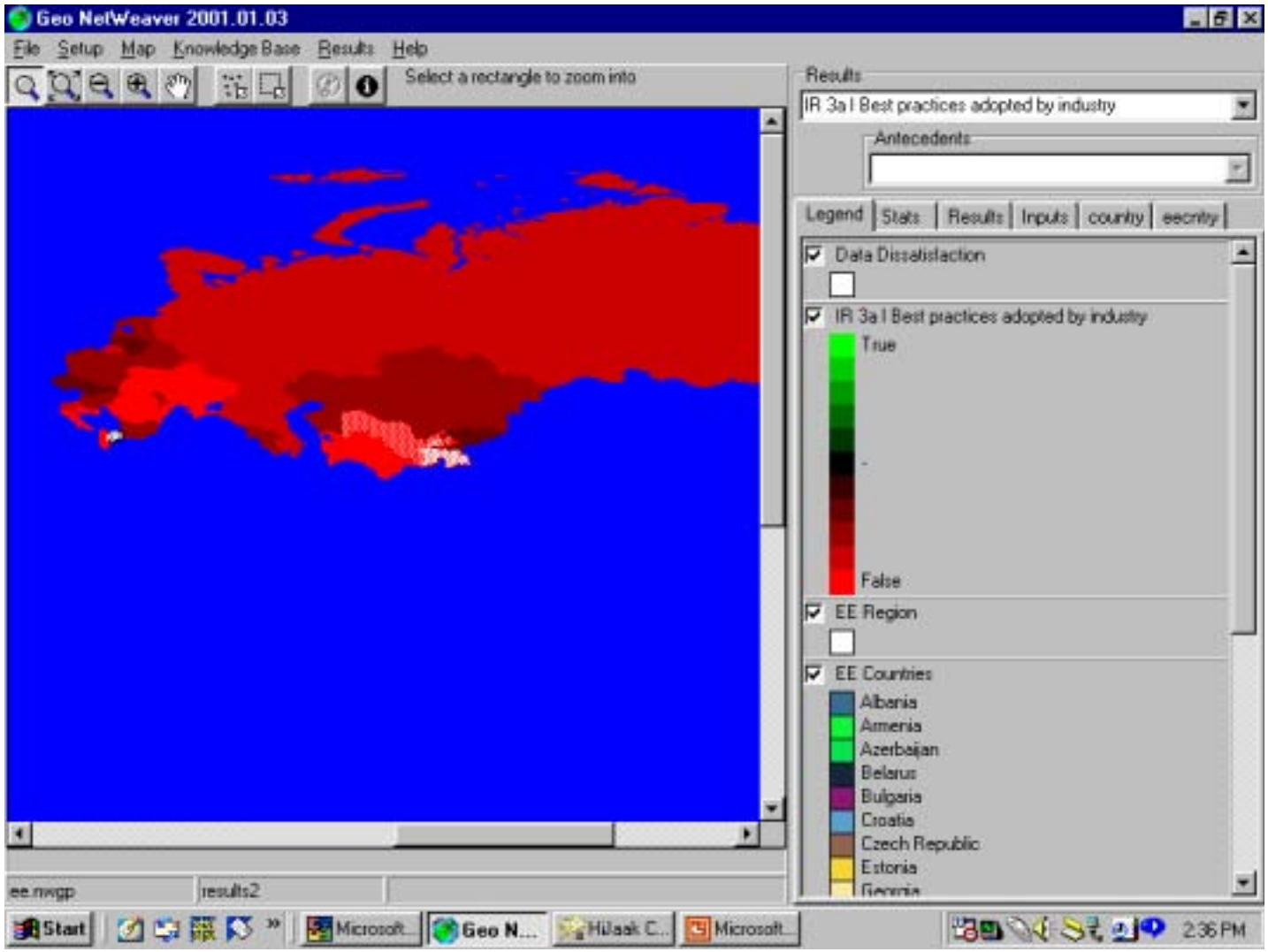
Results of GeoNetWeaver Analysis of Data by Country for SO 1.6



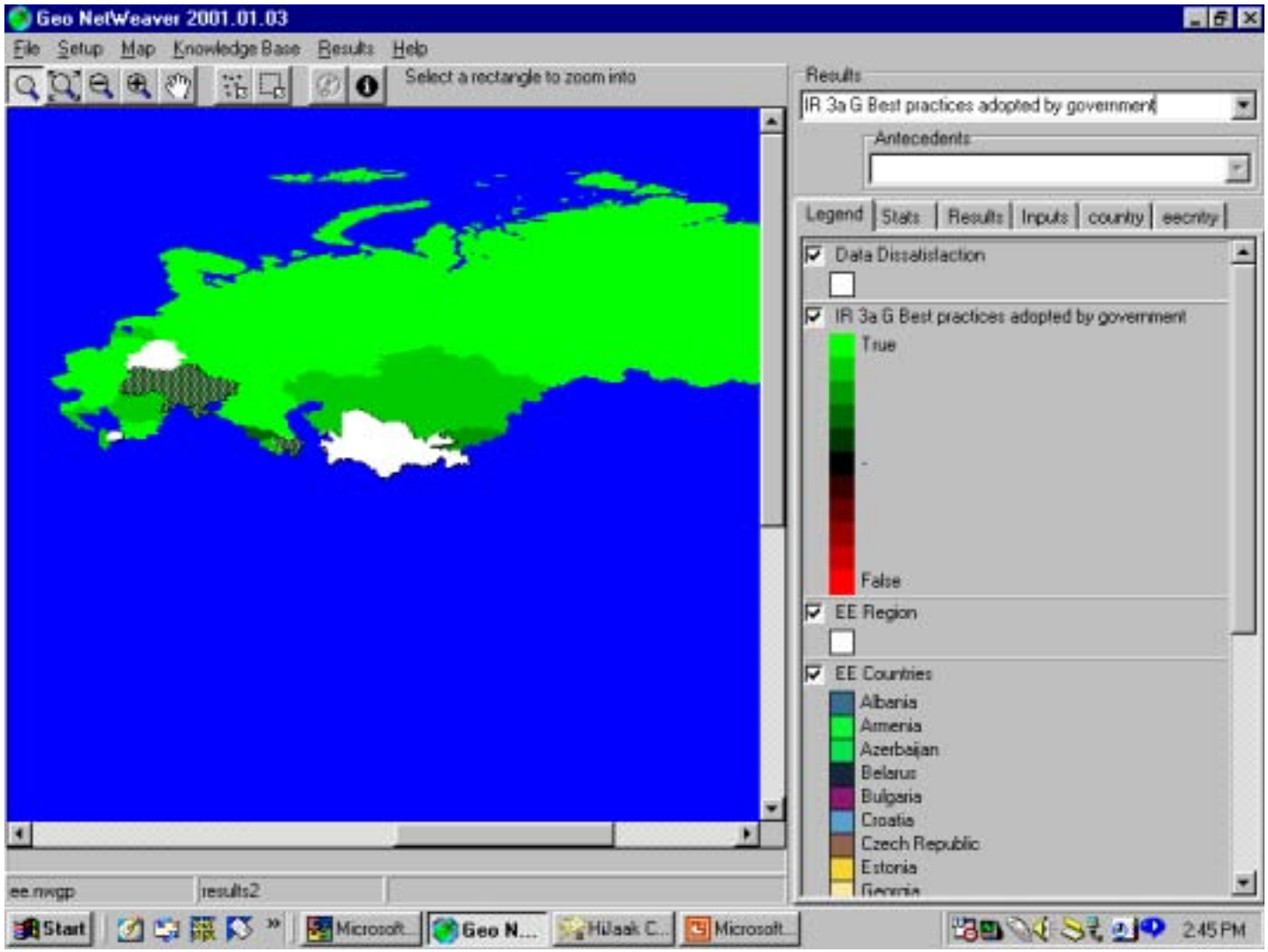
Results of GeoNetWeaver Analysis of Data by Country for IR 3a (Industry and Public Sector Combined)



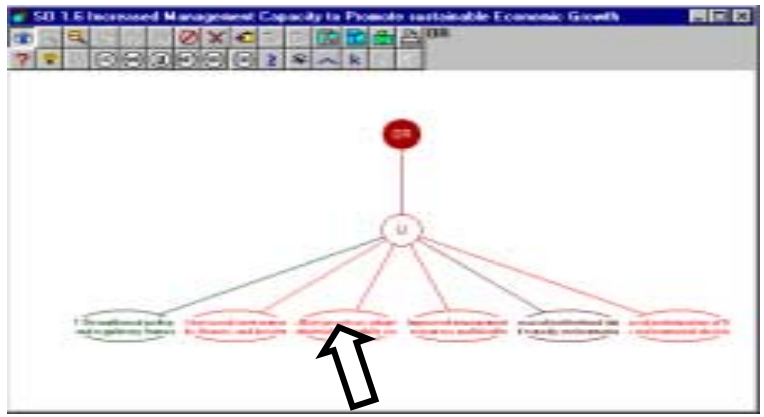
Results of GeoNetWeaver Analysis of Data by Country for IR 3a (Industrial Sector)

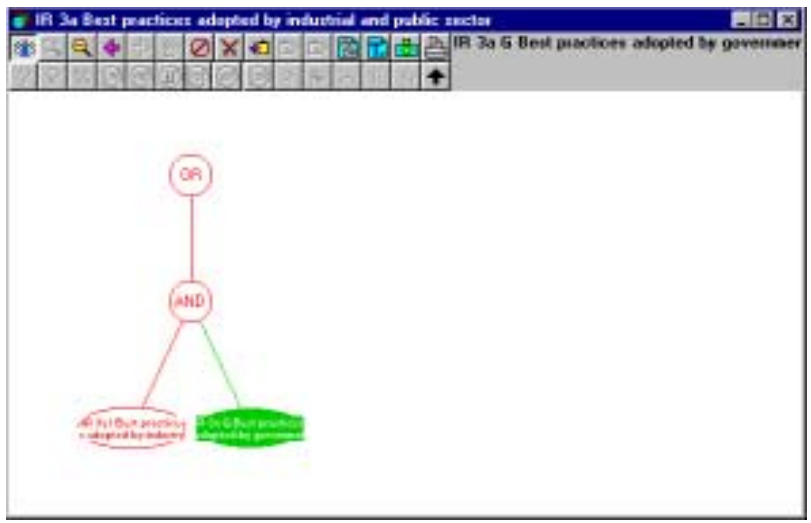


Results of GeoNetWeaver Analysis of Data by Country for IR 3a (Public Sector)

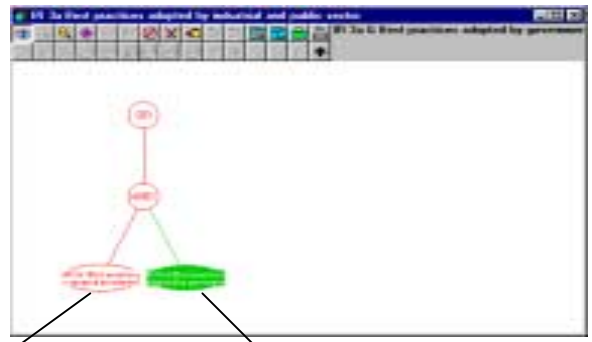


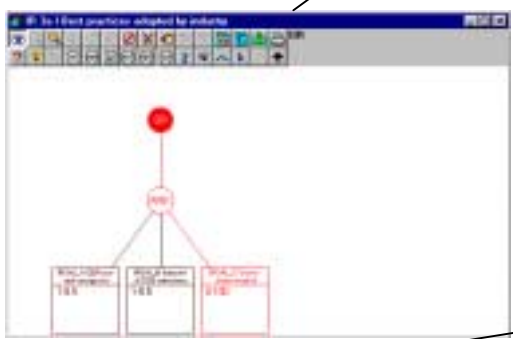
"Drilling down" into a Dependency Network: Romania Example

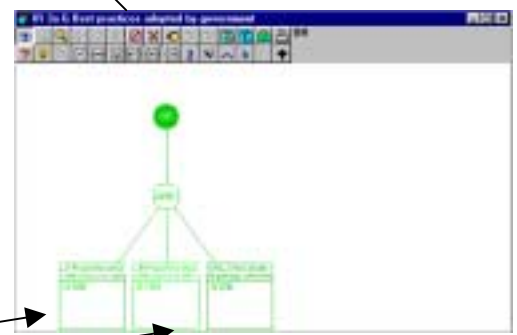




"Drilling down" into a Dependency Network: Example of Data from Rumania







Legend | Stats | Results | Inputs | country | eecntry

	Name		Sourc
	IR1_1 EBRD NEAP score	2	eecntr
	IR1_2 Agreements signed and rat	0.571	eecntr
	IR1_3 EBRD Standards index	2	eecntr
	IR2_1 Environmental trade growth	10.8	eecntr
	IR2_2_2 Securities markets and r	2	eecntr
	IR2_21_1 Finance indicator of EE	0	eecntr
	IR2_22 Banking reform and intere	2.67	eecntr
	IR3AG_A Proportion urban popula	90	eecntr
	IR3AG_B Proportion urban popula	98	eecntr
	IR3AG_C Households with garbag	86	eecntr
	IR3AI_A GDP per unit energy use	3.2	eecntr
	IR3AI_B Industrial CO2 emissions	3.495	eecntr
	IR3AI_C Waste water treated	0	eecntr
	IR3B_A_T Sum of international pr	0.17	eecntr
	IR3B_B2 Percent land area prote	4.6	eecntr
	IR3B_C Percent change in forest	0	eecntr
	IR4_A Central government budge	0.6	eecntr